Experimental Approaches to Understanding Conflict over Natural Resources

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EXPERIMENTAL APPROACHES TO UNDERSTANDING CONFLICT OVER NATURAL RESOURCES

Abstract

Throughout the world, ethnic, racial and religious conflicts over limited resources persist in the face of potential settlements that plainly serve the interests of all sides. When analyzing such conflict, economists tend to ignore "non-material" aspects of decision-making such as inter- and intra-cultural relationships. Such aspects are typically analyzed by sociologists, anthropologists, and political scientists. Using an experimental approach, we demonstrate that economists can indeed make a contribution to understanding the way in which cultural relationships affect economic behavior. Specifically, we examine how the ethnic mix of experimental bargaining sessions affects economic outcomes. Using subjects from two ethnicities that co-exist in an industrialized society, the Hispanic and Navajo cultures in the southwestern United States, we present clear evidence that subjects of different cultures behave differently and that their behavior is affected by interactions with individuals from another culture. Our experimental framework offers the potential to gain insights into the allocation of natural resources in societies of mixed ethnicity, race and religion.

Experimental Approaches to
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I. Introduction

Throughout the world, ethnic, racial and religious conflicts over limited resources persist in the face of potential settlements that plainly serve the interests of all sides. For example, in many parts of the world, there is conflict and tensions over the allocation of scarce freshwater resources (Gleick 1998). Environmental economists have generally left the study of such conflicts to sociologists, political scientists and anthropologists.

Research in these other disciplines has highlighted the role that cultural differences among competing groups can have in determining environmental outcomes. In summarizing the main thrust of this area of research, Adams et al. (2003) argue that

> "[a]lthough conflict is a feature of many resource management regimes, it is often assumed to reflect differences in material interests between stakeholders….Conflicts over the management of common pool resources are not simply material….and the origins of conflict go beyond material incompatibilities. They arise at a deeper cognitive level….One cannot, therefore, simply analyze the economic interests of different claimants to rights over a defined resource. Different people will see different resources in a landscape."

Kim (2003), a political scientist analyzing a conservation and development project in Korea, argues that conflicts can be "culturally constructed" and difficult to resolve because of the way in which interacting cultures frame the resource dilemmas in which they are playing. In a recent edited volume on local-level environmental outcomes, Agrawal and Gibson (2001: 15) emphasize that explicitly considering the heterogeneity of communities along gender and ethnic lines ("differentiated relations of community actors") is one "of the most important issues confronting the research and practice of local-level conservation efforts." Of the eleven authors in the edited volume, none are economists.

The absence of economists in this area of research is unfortunate. By building on advances in behavioral economics and experimental methods, economists can make important contributions to our understanding of the ways in which "culture" affects economic decision-making. Through a combination of simple economic theory and experimental methods, we offer

a demonstration of how economists can contribute to knowledge about the role of cultural diversity and conflict in competition and cooperation over environmental resources.

We are not the first economists to explore the role of culture in economic decision-making. Some authors have focused on cross-cultural differences in behavior (e.g., Brandts *et al.*, 2004; Henrich, 2000; Croson and Buchan, 1999; Burlando and Hey, 1997; Roth *et al.* 1991). In particular, an initiative to explore the effect of culture in 15 small-scale societies across the globe has found striking variability in the outcomes of economic experiments (Henrich *et al.*, 2001, 2003).

In another area of research, a controversial empirical literature has developed over the role that cultural diversity may play in explaining cross-national or cross-regional differences in economic outcomes. Some authors (e.g., Easterly and Levine 1997; Alesina *et al.* 2003) find that there is an inverse relationship between economic growth and cultural diversity, while others (e.g., Collier 2001; Fearon 2003) contest this conclusion. Other authors (e.g., Alesina *et al.* 1997; Miguel 1999) find that cultural diversity is an important determinant of local public finances. In particular, they find an inverse relationship between diversity and spending on public goods such as education, roads and sewers, which they attribute to majority cultures reacting to the size of minority groups.

Our paper provides an experimental framework that can tie together these disparate literatures and help economists move toward a synthesis of the effects that "culture" has on economic behavior and outcomes. To illustrate the use and potential of this experimental framework, we organized experimental sessions of a simple bargaining game with members of two cultural groups from New Mexico: Navajo Indians and Hispanic Americans. We varied the cultural mix of our experimental sessions in order to infer the effect of inter-cultural interactions on economic behavior. In the next section, we define what we mean by "culture" and describe the way in which our study builds on previous experimental research. In Section III, we describe the design of our experiments. Results are reported in sections IV and V and, in Section VI, we present a simulation based on these results. Concluding remarks are offered in section VII.

II. Culture, Ethnicity and Race

Our experiments were conducted in Albuquerque, New Mexico, during July 2002. New Mexico is arguably the most unique state in the U.S. in terms of ethnic diversity, with three

major ethnic groups each accounting for a sizable proportion of the population. In 2001, New Mexico's population was 42.1% Hispanic, 45% Anglo, and 10% Native American, with Blacks and Asians accounting for the remaining 2.9%.[1] New Mexico has a higher Hispanic population, in terms of percentage of total population, than any other state in the U.S. Other states have a higher proportion of Native Americans, but no other state has a mix of Anglos, Hispanics, and Native Americans comparable to New Mexico. Native American and Hispanic cultures are distinct and dominant in the state, and in the City of Albuquerque.

Economists who work with concepts like culture, ethnicity and race rarely attempt to define such words. Their definitions, however, are subject to much debate in other disciplines (McElreath et al., 2003).[2] We use the word "culture" to refer to the statistical distribution of beliefs, values and modes of thinking that shape behavior among a group of people (e.g., notions of fairness). "Ethnicity" is related to symbolically marked groups (e.g., marked by language, dialect or clothing). Cultural differences may be present in a population when ethnicity is not marked (e.g., southern-born and northern-born whites in the United States; Nisbett and Cohen, 1996). Similarly, ethnic differences may exist when no cultural differences exist (except for the ethnic marking). "Race" is like ethnicity, except the "markers" are genetically transmitted (Gil-White, 2001).

We assume that self-reported Navajo and Hispanic individuals in our experiments are distinct culturally, ethnically and racially. We are testing whether such distinctions make any difference in the bargaining behavior of our subjects. In our experiment, we cannot differentiate the separate effects of culture, ethnicity and race; empirically, they are identical for our purposes. Thus we will use the term "cultural differences" to describe any differences that result from differences in culture, ethnicity or race. As in previous papers that find relationships between an individual's culture, ethnicity or race and his or her behavior or economic status, we can never be certain that what we describe as cultural determinants are not actually non-cultural determinants, for which we have no data, that are correlated with our cultural categories. In this sense, what we call "culture" in our analysis is best viewed as a residual category. By controlling for differences in behavior that stem from variability in the socio-economic attributes of our

[1] Department of Commerce website: Statistical Abstract of the U.S., 2001, Washington, DC, Tables 23 and 24.

[2] The authors thank anthropologist Joseph Henrich (Emory University) for helping us to come to grips with these terms and directing us to the relevant literature.

subjects, we attribute to "cultural differences" any remaining variability in behavior across ethnic groups.

As mentioned above, experimental economists have generally ignored the question, "Do individuals interacting with others sharing the same culture behave differently than when interacting with others from a *different* culture?" We find only two published studies that address the inter-cultural question: Fershtman and Gneezy (2001; hereafter FG) and List (2004).[3]

In a series of experiments with two major Israeli ethnic groups, the Ashkenazic Jews (European and American immigrants and their Israeli-born offspring) and the Eastern Jews (Asian and African immigrants and their Israeli-born offspring), FG addressed the effects of ethnic stereotyping on trust and the ability of two players to cooperate. In their application of the Ultimatum Game, FG found significantly larger offers were proposed to Eastern players.[4] However, they found no significant difference between the percent of Eastern and Ashkenazic players that rejected a proposed split of 25% of the pie.

FG write (p. 370) that the observed discrimination "is probably an outcome of a common ethnic stereotype in Israeli society, according to which men of Eastern origin are believed to react more harshly if treated unfairly." Absent information about players' expectations of partner responses, however, FG were unable to determine if the observed discrimination derived from erroneous statistical discrimination or a "taste for discrimination." We return to this issue later in our analysis.

List (2004) examined the bargaining behaviors of participants in a real sportscard market. He observed starting and final offers for a specific card and collected information on basic attributes of the bargainers (age, experience, gender, education, income, height and weight) and the length of the bargaining session. He had subjects from four categories: white males aged 20-30, white females aged 20-30, white males aged 60+, and "nonwhite" males aged 20-30. Given that race was not asked on the questionnaire, it is unclear as to how the author determined race and what race, or races, the term "nonwhite" includes for his sample.

List found that average initial and final offers from dealers to "minority" buyers (females, older males, and nonwhite males) were lower than those received by young white males. After

[3] We note, however, the interesting unpublished study of the ultimatum game with ethnicity manipulation (between two Mongolian tribes) by Gil-White (no date).

[4] FG do not make clear whether this discrimination was observed only with Ashkenazic Proposers or both Eastern (n=33) and Ashkenazic (n=24) Proposers.

controlling for experience, the differences were small for experienced buyers (but minority buyers did have to spend more time to obtain a similar outcome) and were only significantly different among inexperienced older male and young female buyers.[5] Unlike FG, List used complementary "laboratory" experiments (Dictator Game, Decentralized Chamberlain Market, and a Vickery second-price auction for a real card) to elucidate the underlying reasons for the observed discrimination in the real sportscard market. The data in the complementary experiments suggest that the observations in the real sportscard market were a result of statistical discrimination by dealers rather than preference-based discrimination.

Two interrelated issues motivate our analysis below. First, we wish to ensure that we do not attribute to "culture" any differences in behavior that stem from variability in the socio-economic attributes of our subjects. For example, FG analyzed only the behavior of the male Proposers in their Ultimatum Game and did not analyze rejections controlling for the gender (or ethnicity) of the subject making the offer. Other studies, however, have found significant gender effects in the Ultimatum Game (Eckel and Grossman, 2001; Solnick, 2001; Botelho *et al.*, 2002). FG also did not control for socio-economic differences across subjects (e.g., Ashkenazic Jews tend to be wealthier). List, in contrast, controls for gender, length of bargaining session, average frequency of buyer transactions per month, years of market experience, income, and education.

Our second motivation relates to common practices used by economists to control for subject characteristics, particularly ethnicity, and is relevant whether or not subjects from the two cultures behave differently in the Ultimatum Game when each player's partner is from the same culture. We wish to determine if the *ethnic mix* of the experimental session affects how subjects make decisions. FG's inquiry into the existence of inter-cultural discrimination is based on a design wherein players attempt to infer the ethnicity of their partners, who are in a different location, from the partners' surnames -- subjects assume they are either playing with a partner of the same or a different ethnic group. In List, subjects can either observe the race, gender, or approximate age of their partner or are told these attributes by the experimenter.

While these may be important contexts, we wish to explore behavioral variability in response to changes in the *proportional representation* of the two ethnic groups in an experimental session. In other words, we wish to determine if subjects behave differently in the

[5] Similar results are presented for the offers made by dealers to minority sellers, but the differences are not statistically as meaningful.

following three contexts: (1) all players share the subject's ethnicity, (2) the player's ethnic group makes up a large majority of the players, and (3) the player's ethnic group is a small minority of the players. If subject behavior is affected by the ethnic mix of a session, several considerations arise that are relevant for public policy and for the manner in which economists control for ethnicity in empirical analyses. Public administration often takes place in societies characterized by mixed ethnicities, in which one or two ethnicities dominate. In empirical economic analyses, economists commonly use simple dummy (zero-one) variables to control for ethnicity, race and religion. If, however, subject behavior is affected by the cultural mix rather than (or in addition to) the subject's own culture, economists may need to reconsider the way in which they control for cultural differences in empirical analyses.

III. Experiment Design

We analyze our problem in the simplest of bargaining environments: the ultimatum bargaining game. Two players, a Proposer and a Responder, bargain over $10. The Proposer offers $$x$ to the Responder, leaving himself \$10-x. The Responder can either take the offer, in which case each obtains the proposed split of the $10 pie, or reject it and both get nothing. As noted by Camerer (2003: 8), the ultimatum game is too simple to be a good model of the complicated processes of most real-world bargaining. Yet because it is simple, it offers a useful environment for testing hypotheses about the factors that influence how people feel about the allocations of money between themselves and others. It is thus unsurprising that previous cross-cultural studies and the Fershtman-Gneezy intercultural study have used the Ultimatum Game as a vehicle for understanding the way in which culture affects economic behavior.

The experimental sessions were held in a large room rented at the Menaul School, centrally located in Albuquerque. A portable experimental laboratory was used that consists of 32 networked notebook computers with wireless connection to a laptop computer that acts as a server. Subject computers are situated in folding partitions to ensure private decisions. The instructions for the experiments were conveyed orally and in writing. A portable projector demonstrated the subject interface (see appendix for instructions). Prior to each session, subjects were placed in a room in which some food and refreshments were offered. We grouped subjects prior to entering the experimental room for two reasons: (1) such grouping allowed subjects to observe the ethnic makeup of their session (Navajo and Hispanic subjects are visually very

different) and (2) it allowed us to conduct back-to-back sessions without risking cross-session observation or communication.

Sixty Hispanic subjects were recruited by distributing flyers in Hispanic neighborhoods. All of our Hispanic subjects were raised in the United States. Sixty Navajo subjects were recruited primarily by distributing flyers at three Navajo organizations: the Southwest Indian Polytechnic Institute (SIPI), the PHS Indian Hospital, and the Albuquerque Indian Center. "Navajo neighborhoods" do not exist and these organizations serve as the closest equivalent. Overall, 45% of the subject pool was male, 59% reported an annual income of less than $15,000, 47% of the sample was full- or part-time students, 15% was married and the mean age was 29 years.

In order to explore cross-cultural and inter-cultural effects on behavior, we scheduled four experimental sessions. The ethnic composition of each session was as follows:[6]

Session 1 (All-Hispanic)	30 Hispanic subjects
Session 2 (Majority-Hispanic)	21 Hispanics subjects and 6 Navajo subjects
Session 3 (All-Navajo)	29 Navajo subjects and 1 Hispanic subject[7]
Session 4 (Majority-Navajo)	23 Navajo subjects and 7 Hispanic subjects.

[6] Only 117 of 120 observations were usable. Given our concern with offending subjects or the organizations providing subjects, we chose to allow subjects to complete the experiment even if they were unable to successfully complete practice questions or were demonstrably unable to comprehend questions. As a result, we exclude data from three subjects: one Navajo subject from the All-Navajo session who could not respond to the practice question (even after repeated explanations by the experimenter), could not understand how to use the mouse, and rejected every possible offer; and one Navajo subject from the All-Navajo session and one Hispanic subject from the Majority-Hispanic session, both of whom had obvious difficulty completing the practice question and who then clicked reject and accept in alternating fashion for every potential offer that could be sent to them. For these three subjects, the idea of a minimum acceptable offer makes no sense and it is unlikely that these subjects understood the main components of the experiment. We note, however, that including these subjects in the analysis by treating their first accepted offers as their Responder reservation prices does not affect our results. When estimating the percentage of Navajo and Hispanic in a session, we include these subjects because they were observable to every subject in the room (removing them from the percentage calculation does not affect our results).

[7] Native American ethnicity is a requirement for entry into these organizations. Thus, presumably all subjects in the All-Navajo session were Navajo. However, one subject selected "Hispanic" on the post-experiment questionnaire. We are unsure if the subject was indeed Hispanic, was of mixed heritage and did not see the option for mixed ethnicity, or made a mistake filling out the questionnaire, which was completed on a computer. We treat the subject as Hispanic, but note that deleting this subject or re-coding her as "Navajo" does not affect our results.

Session 1 followed immediately by Session 2 took place on one night, and Session 3 followed immediately by Session 4 took place the next night.

The standard rules of the Ultimatum Game were explained to subjects and subjects were required to complete a practice question to ensure they understood how their earnings would be calculated (see Davis and Holt (1993) or Roth (1995) for more information on Ultimatum Games). Subjects played the role of *both* Responder and Proposer (as was done in the original application of the Ultimatum Game by Güth *et al.* (1982) and in more recent studies like Andreoni *et al.* (2003), Carter and Irons (1991), and Kahneman *et al.* (1986)). Subjects were told that they would make decisions as a Responder and as a Proposer. At the end of the experiment, the computer randomly assigned each subject to the role of Responder or Proposer, and randomly paired the subject with another subject in the room (not known to him or her) who played the opposite role. Subjects were cautioned to take each role seriously given the equal chance that each person had of being assigned the role of Responder or Proposer. With the exception of the All-Navajo and All-Hispanic sessions, the ethnicity of a subject's partner was uncertain but the ethnic composition of the session was obvious: the subject's ethnic group constituted either a large majority or a small minority of the subjects.

As an aside, we note that our design differs from FG's in that subjects from one culture interact *directly* with subjects from the other culture. The only contact that an Ashkenazic subject in FG's experiment had with an Eastern subject was a visual inspection of the Eastern subject's name on a form.[8]

The amount of money given to the Proposer, known by all subjects, was $10.00. Subjects first saw a screen (Figure 1) that asked them to make the decisions of a Responder. They were asked to indicate, for each dollar amount between $0 and $10, *if* they were assigned the role of Responder and *if* that dollar amount were sent to them, whether they would accept it or reject it; i.e., we used the strategy method. Eliciting the behavior of Responders through the strategy method allowed us to collect data on all information sets of the game, not just those that were actually reached in the course of the game. Subjects were cautioned that, if assigned the role of Responder, they would be bound by the decisions that they recorded on this screen.

[8] In Gil-White's (no date) experiment, subjects' viewed photographs of the 20 potential partners.

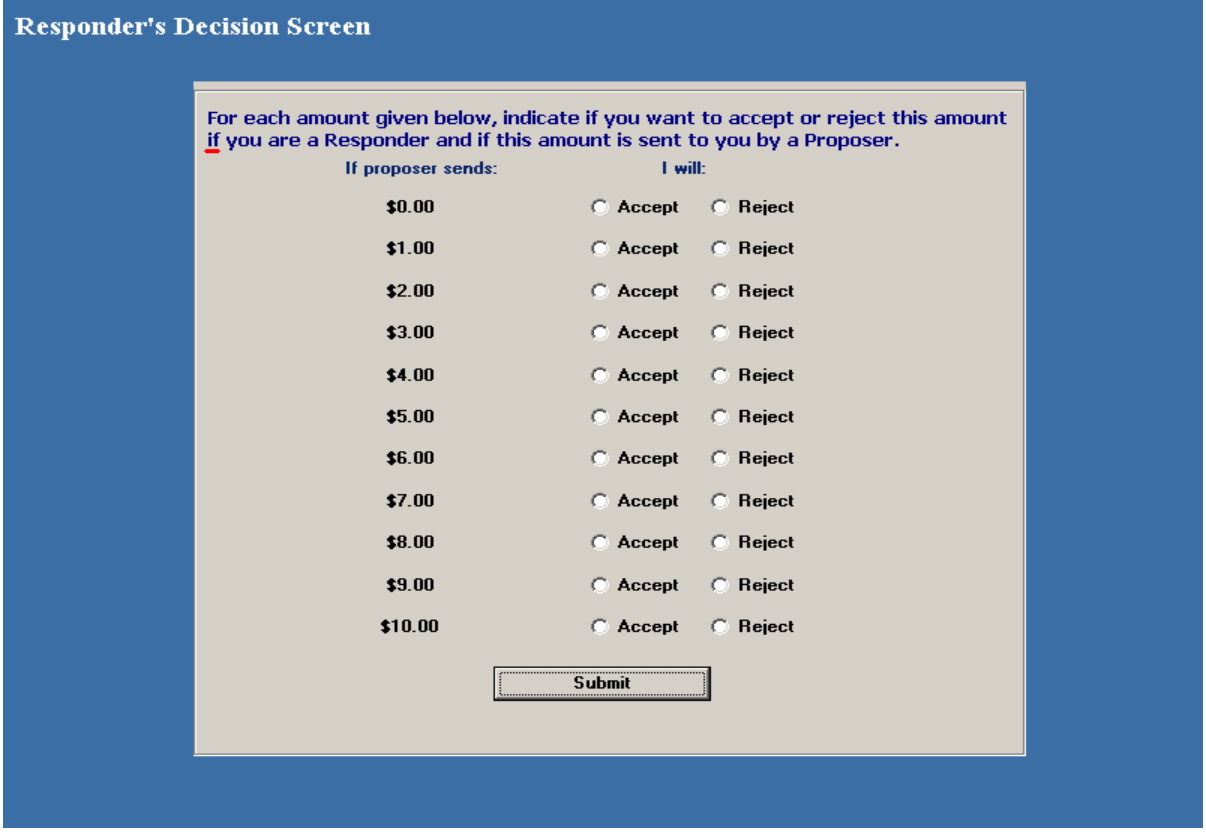

Figure 1 – Responder Screen

Subjects were then asked to play the role of a Proposer. To allow us to make inferences about discriminatory behavior that may be observed in the laboratory, subjects were first asked *to predict* how they believed Responders would respond to each possible amount that they might send to a Responder, from $0 to $10 (Figure 2 below). Subjects predicted the *percent* of Responders in the session that would accept each amount. To create incentives for subjects to think about their estimates, subjects were informed that the individual whose estimates were the closest to the actual percent of Responders accepting each amount would win $10.00.[9]

[9] More specifically, they were told that the absolute values of the differences between their predicted percentages and the actual percentages for each potential offer would be summed. The subject with the *lowest sum* wins the $10.00. We do not claim that this method is incentive-compatible (we gratefully acknowledge related comments offered by Uri Gneezy). However, our payment rule is highly transparent and can include truth telling as one best response, while a best response that deviates from true beliefs under this rule requires sophisticated strategizing about the beliefs of others in the session and mathematical acumen to solve for a best-response conditional on those

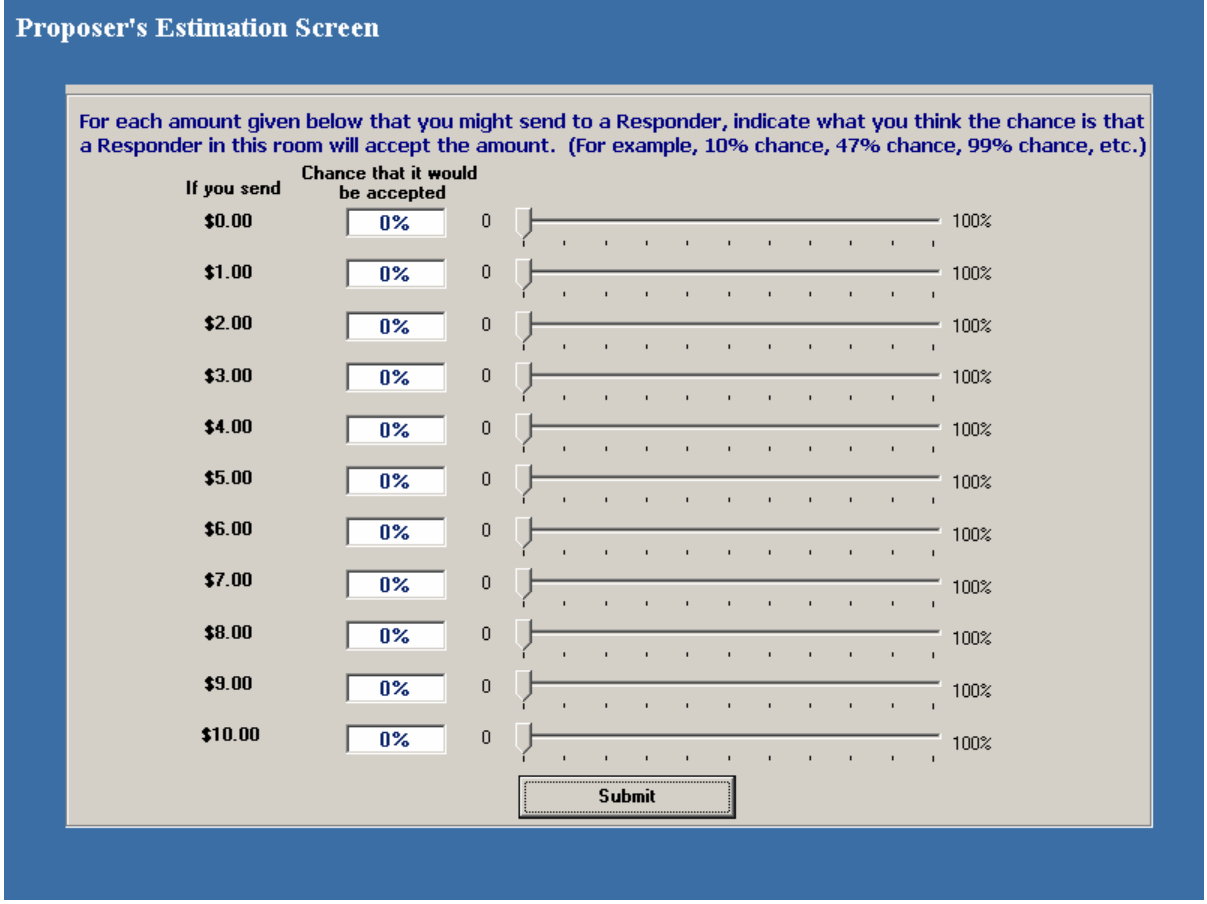

Figure 2 – Proposer's Expectations of the Likelihood of Offer Rejection

Subjects were then asked to decide how much they would send to a Responder *if* they were assigned the role of a Proposer (Figure 3). Subjects were advised that if assigned the role of Proposer, the amount they chose on this screen would be sent to the Responder.

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beliefs. Moreover, a recent study by two economists who have published numerous experiments using incentive-compatible quadratic scoring rules (Sonnemans and Offerman, 2001) found no significant difference between the beliefs elicited from a sophisticated quadratic scoring rule that corrects for undesired effects of risk attitudes and probability weighting and beliefs elicited from a method that simply pays subjects a fixed (unconditional) payment: the offer of some compensation for effort was enough to induce subjects to think carefully about their beliefs.

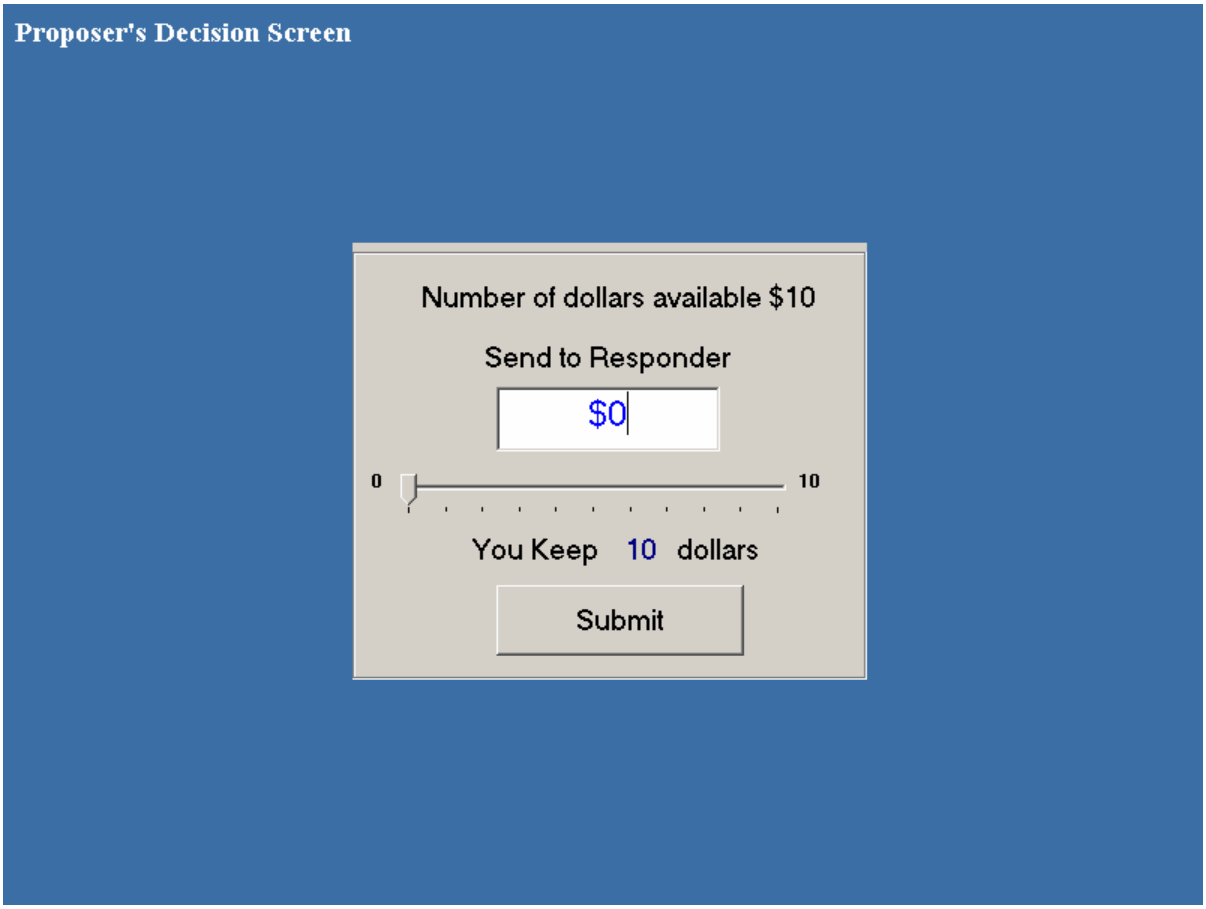
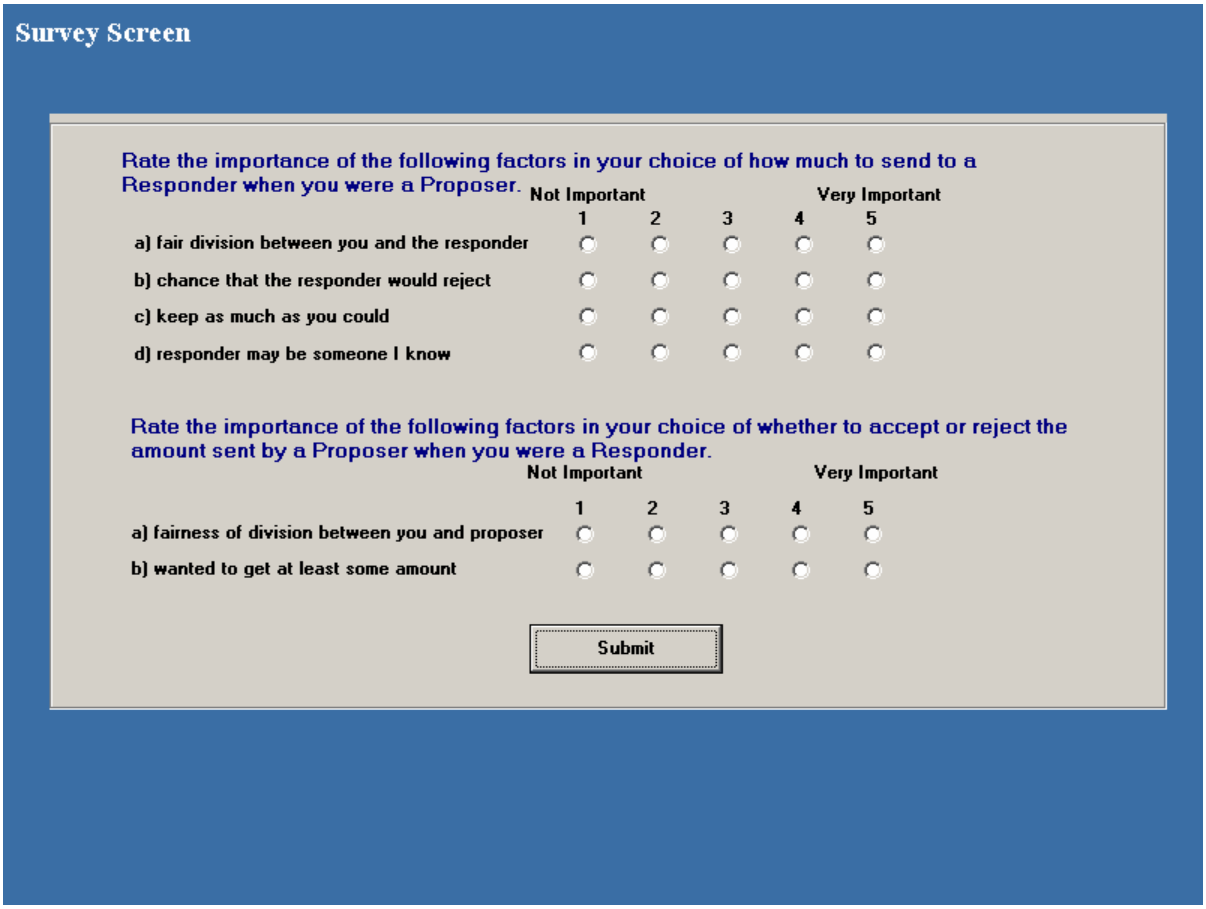


Figure 3 – Proposer's Screen

Finally, subjects responded to a questionnaire (Figure 4) that inquired about the motivations for the decisions made by the subject as a Responder (Figure 1) and as a Proposer (Figure 3). At the end of the session, demographic information was obtained from each subject. The same person conducted all the sessions.

Figure 4 – Post-Experiment Questionnaire of Subject Motivations



IV. Results – Summary Statistics

A summary of the results from the four experimental sessions is given in Table 1. This summary shows rough trends in the data. In the next section (V), we control for demographic and other subject characteristics in the analysis.

Responders

We begin by examining the behavior of Responders. Hispanic Responders have higher minimum acceptable offers, on average, than Navajo Responders in all sessions (significant at 2%-11% level, depending on the session, under Mann-Whitney and t-tests). In the All-Navajo and All-Hispanic sessions, 60% of both ethnicities were willing to accept an offer of 10% of the pie ($1). These acceptance rates are substantially higher than those observed in previous Ultimatum Game experiments in industrialized nations. Güth *et al.* (2003) report that anything over 33% is much higher than the rates typically observed in Ultimatum Game experiments that use the strategy method (including experiments in which subjects played both roles).[10]

Table 1. General Summary of Experiment Results

	..... **Responder**.....				..... **Proposer**.....	
	Average reservation price:		% responders accepting $1.00		Average offer:	
Session	Navajo	Hispanic	Navajo	Hispanic	Navajo	Hispanic
All subjects same ethnicity	$1.31	$1.83	62%	60%	$3.83	$4.90
Subject's ethnicity is a majority	$1.78	$2.73	61%	33%	$5.13	$4.77
Subject's ethnicity is a minority	$2.00	$3.38	50%	13%	$4.17[11]	$4.50

Furthermore, both Hispanics and Navajos appear to discriminate against the other ethnic group -- there is an increase in the minimum offer that they would accept as the relative proportion of their ethnic group in the session decreases. This increase is particularly notable for the Hispanics.[12] The same pattern appears in the percent of subjects willing to accept an offer of one dollar. Both Hispanics and Navajo become more willing to accept the one-dollar offer as the

[10] Our anomalous results are not likely to be a result of having players play both roles. Conducting the same experiment at Georgia State University, we find only one-third willing to accept $1 *or* $2 (mean reservation price was $2.77). The mean offer in this session was $4.17. This session of 30 subjects had no culture in a majority or substantial minority: 16 males, 14 foreign subjects from 10 different nations, 5 Hispanic, 3 African-American, and 8 White.

[11] The mean offer increases from $4.17 to $5 if one influential subject is removed. We will discuss this influential observation (subject #33) in the next section.

[12] Results from a Jonckheere-Terpstra test (with exact p-values) indicate a significant difference in Hispanic Responder behavior across sessions (p=0.0015). No such significant difference is found among Navajo Responders (p=0.2837). The JT test is a nonparametric test for ordered differences (trend) among classes and is preferable in this context to tests of more general class differences (e.g., Kruskal-Wallis H test; Hollander and Wolfe, 1998).

proportion of their ethnic group in the session increases. Again, the behavior on the part of Hispanics is more striking. Thus Navajo are willing to accept low offers at much higher rates than most other subjects in previous Ultimatum Game experiments, whereas Hispanic acceptance rates are only unusually high when playing in an All-Hispanic group.

Proposers

Offers by both Hispanic and Navajo Proposers are in the range observed in earlier studies regardless of their proportion of the session: between 38% and about 50% of the $10.00 to be divided. When playing with members of one's own ethnic group, however, Navajos make significantly lower offers than Hispanics (significant at 1% level under both a Mann-Whitney and t-test). In addition, Hispanics appear to persistently discriminate against the Navajo -- Hispanic offers appear to decline as their majority status diminishes – while Navajos appear to make higher offers when Hispanics are in the session.[13]

IV. Results – Regression Analyses

The summary statistics in the previous section do not, of course, control for demographic variability among subjects or the differences in ethnic proportions across sessions. There was a high degree of variability in our subject pool with, for example, ages ranging from 16 to 50 years old and annual incomes ranging from less than $5,000 to more than $50,000. Such variability affected the demographic composition across sessions. For example, among Hispanic subjects in the All-Hispanic session, the mean age was 32.3 years and 40% reported incomes less than $5000 per year. For Hispanic subjects in the Majority-Navajo session, the mean age was 22.1 years and 12.5% reported incomes less than $5000 per year. Similar variability existed among Navajos across sessions. As we wrote in Section II, some studies have found that demographic attributes are important determinants of behavior in the Ultimatum Game (Harbaugh *et al.*, 2002; Botelho *et al.*, 2002; Eckel and Grossman, 2001; Solnick, 2001; Stanley and Tran, 1998; Carter and Irons, 1991; Kahneman, Knetsch, and Thaler, 1986).[14] To control for their effects, and to allow us to focus on our two major questions, we conduct regression analyses of Proposers'

[13] Results from a Jonckheere-Terpstra test (with exact p-values) indicate significant differences in Proposer behavior across sessions for both the Navajos (p=0.0237) and Hispanics (p=0.0590).

[14] Although previous Ultimatum Game studies have not included marital status (probably because most of the subjects were young college students), 15% of our subject pool was married and we hypothesized that married subjects may behave differently in a bargaining situation

offers and Responders' minimum acceptable offers (reservation prices) against the variables listed in Table 3.

Hispanic ethnicity is the omitted ethnicity variable in the models. Inter-ethnic effects are measured by the variables (2), (3), and (3.a) (3.a is used only in Offer regression). The squared interaction term (3.a) between Navajo and percent of subjects in a session from a different ethnic group is included as a result of our finding a non-linear relationship between Navajo Proposer behavior and the ethnic composition of the session.[15] As we will note, however, this non-linearity is largely a result of the behavior of two subjects. Such non-linearity was not observed among Hispanics.

We also estimated a model in which behavioral variables (i.e., responses from questions in Figures 2 and 4) and expectations were included, but these regressions do not change the qualitative results of our analysis of cross-cultural and inter-cultural effects on decision-making (see Ferraro and Cummings, 2003, for other regressions). Given evidence of heteroskedasticity, we use the Huber/White/sandwich estimator of variance (White, 1980), which produces robust estimates of the standard errors.[16]

Table 3. Variables Used In Regression Analyses

	Variable	Description
Dependent variables:	RESERV	Responder's reservation price
	OFFER	Proposer's offer
Independent variables:		
1. Navajo		Dummy variable = 1 if subject is Navajo
2. PercentOther		Percent of subjects in session from an ethnic group *different* from that of the subject's [0%, 96.9%]
3. NavPercentOther		Interaction between (1) and (2)
3.a $(\text{NavPercentOther})^2$		(3) squared, used only in Offer equation
4. Age		Subject's age

[15] We detected this non-linearity using Mallows (1986) augmented component-plus-residuals plot, a sensitive test of non-linearity.

[16] We also used Davidson and MacKinnon's (1993) more conservative HC3 estimator without a substantial change in the standard errors. All regressions were run in Stata v.7.

5.	Male	Dummy variable = 1 if subject is male
6.	Econ	Number of economics courses taken by subject
7.	Less$15000	Dummy variable = 1 if subject's income is less than $15,000
8.	$15_$45000	Dummy variable = 1 if subject's income is between $15,000 and $45,000
9.	NavLess$15000	Interaction term between (1) and (7)
10.	Nav$15-$45	Interaction term between (1) and (8)
11.	Married	Dummy variable = 1 if subject is married

Results from the regressions of Responder behavior (RESERV) and Proposer behavior (OFFER) are presented in Tables 4 and 5. These results will serve as a basis for responses to the two questions raised in Section 2: (1) Do we observed cross-cultural differences in Ultimatum Game behavior of subjects from these two cultures that share the same geographic area? and (2) Do changes in the proportional representation of an ethnic group substantially affect behavior in the Ultimatum Game? We answer these questions by first examining the behavior of Responders, and then the behavior of Proposers.

Responders

With respect to *cross*-cultural effects, Navajos have significantly lower reservation prices, on average, than Hispanics (Table 4). For example, the ethnicity coefficients suggest that, depending on income, a Navajo subject will accept, on average, between $0.35 - $2.80 *less* than a Hispanic subject.

With respect to our second question concerning *inter*-cultural effects, the behaviors of both Hispanic and Navajo Proposers are significantly affected by the ethnic composition of the session in both models. Both Hispanics and Navajo discriminate against the other ethnic group in the sense that their mean reservation prices increase with an increase in the proportion of subjects from the other ethnic group; this effect is most pronounced with Hispanic subjects. If, for example, the subject pool were 25% Hispanic and 75% Navajo, the model predicts that the average minimum acceptable offer of Hispanics would be about $1.44 more than if the pool were 100% Hispanic.

With regard to the demographic variables, we observe that Hispanic reservation prices are significantly and positively related to income, whereas such a relationship was not observed for the Navajo (if anything, poorer Navajos demand a little more of the pie). Married subjects, both Hispanic and Navajo, have significantly lower reservation prices than single subjects by almost $1 on average. Evidence of gender effects on a Responder's reservation price is weak, at best, with males requiring about $0.45 less than females on average. A negative effect also derives from exposure to economics courses.[17]

Table 4. Responder's Reservation Price As Dependent Variable

Model 1: F(11,105) = 10.27 (Prob>F=0.000)[18]; R-squared = 0.24; Root MSE = 1.50

Independent Variable	Coefficient (Standard Error)	t-statistic (p-value)
Constant	4.165	5.20
	(0.801)	(0.000)
Navajo	-2.793	-4.35
	(0.642)	(0.000)
PercentOther	0.019	2.88
	(0.007)	(0.005)
NavPercentOther	-0.010	-0.77
	(0.013)	(0.443)
Age	0.011	0.64
	(0.017)	(0.527)
Male	-0.446	-1.53
	(0.292)	(0.130)
Econ	-0.079	-2.31
	(0.032)	(0.023)
Married	-0.969	-2.52
	(0.385)	(0.013)
Less$15,000	-2.355	-4.63
	(0.509)	(0.000)
$15-$45,000	-1.793	-3.94
	(0.456)	(0.000)
NavLess$15,000	2.445	3.20
	(1.027)	(0.002)
Nav$15-$45,000	1.970	2.35
	(0.838)	(0.021)

[17] Removing one subject who reported taking 26 economics courses makes the coefficient smaller (-0.04) and insignificantly different from zero (p = 0.65).
[18] Values of "0.000" imply a value less than 0.001.

Proposers

In terms of *cros*s-cultural effects among Proposers, we find a significant difference in the behavior of our two cultural groups in both models (Table 5). On average, Navajos offer less than Hispanics. For example, the ethnicity coefficients suggest that, depending on income levels, a Navajo subject offers, on average, between $1.27 and $2.50 *less* than a Hispanic subject.

In terms of our *inter*-cultural question -- does the ethnic mix of the session "matter" -- we find the ethnic composition of the session has significant effects on offers. Hispanics make the highest offers to a Responder *when all subjects are Hispanic*, and persistently lower offers as the percent of Hispanics in the group decreases. For example, a Hispanic subject offers, on average, $1 less if Hispanics make up only 25% of the session rather than 100%.

Turning to Navajo Proposers, the non-linear response to ethnic composition that was evident in Table 1 is also reflected in our regression results: mean Navajo offers rise and then fall as their proportional representation of the session decreases (reflected in the significantly positive sum of "PercentOther" and "NavPercentOther" and the significantly negative sign on "NavPercentOther^2"). However, much of this non-linearity is driven by two influential observations. Using Cook's (1997) distance to identify influential observations, we identified two Navajo subjects who offered $0 as the two most influential observations (#29 in the All-Navajo session; #33 in the Majority-Hispanic session). Removing these observations from the data set removes the observed nonlinearity in the data: the coefficient on NavPercentOther^2 is statistically no different from zero. Removing the two influential observations and the squared variable from the regression yields the following coefficients: PercentOther = -0.015 (p=0.013) and NavPercentOther = 0.033 (p=0.006). This result implies that Hispanic offers decrease linearly in the proportion of Navajo subjects in the session (almost 2 cents for every 1% increase in the proportion of Navajos), while Navajo offers *increase* linearly in the proportion of Hispanic subjects in the session (almost 2 cents for every 1% increase in the proportion of Hispanics).

Table 5. Proposer's Offer As Dependent Variable

Model 1: F(12,104) = 1.97 (Prob>F=0.034); R-squared = 0.15; Root MSE = 1.56

Independent Variable	Coefficient (Standard Error)	t-statistic (p-value)
Constant	6.642	7.27
	(0.914)	(0.000)
Navajo	-2.502	-2.17
	(1.151)	(0.032)
PercentOther	-0.013	-1.98
	(0.007)	(0.050)
NavPercentOther	0.107	3.18
	(0.034)	(0.002)
$NavPercentOther^2$	-0.001	-2.75
	(0.000)	(0.007)
Age	-0.029	-1.54
	(0.019)	(0.126)
Male	0.092	0.29
	(0.314)	(0.771)
Econ	0.052	1.62
	(0.032)	(0.109)
Married	-0.245	-0.55
	(0.442)	(0.580)
Less$15,000	-1.060	-2.26
	(0.470)	(0.026)
$15-$45,000	-0.689	-1.46
	(0.472)	(0.147)
NavLess$15,000	1.232	1.20
	(1.027)	(0.233)
Nav$15-$45,000	1.050	0.90
	(1.170)	(0.372)

Predicted Proposer and Responder Behavior

In an effort to make clear the nature of these cross-cultural and inter-cultural effects, an example is given below in Table 6 where we consider two hypothetical subjects: a Navajo and a Hispanic subject, both 25 year-old single females with incomes in the $15,000-$45,000 range. For various ethnic mixes, Table 6 gives the Responder reservation prices and Proposer offers that are predicted by the regressions reported in Tables 4 and 5. Because the non-linearity observed for Proposer Offers was driven by two influential observations, we drop these two observations and use a re-estimated Offer model without the squared term "$NavPercentOther^2$" (from Ferraro and Cummings, 2003).

Table 6.

Comparison of Hypothetical Navajo and Hispanic Subjects with Identical Attributes

	Navajo		Hispanic	
Percent of "other" ethnic group in session	**Minimum Acceptable Offer**	**Offer**	**Minimum Acceptable Offer**	**Offer**
0%	$1.19	$3.13	$2.14	$4.33
20%	$1.37	$3.46	$2.50	$3.95
50%	$1.63	$3.96	$3.03	$3.38
80%	$1.89	$4.45	$3.57	$2.81

In the ethnically homogeneous sessions, reservation prices and offers are substantially different between the Navajo and Hispanic "subjects." Most importantly for our purpose, as the percent of Navajo subjects in a session increases, reservation prices increase and offers decrease for the Hispanic subject. For the Navajo subject, increases in the percent of Hispanics in the session also results in increasing reservation prices; her offer, however, also increases as the percent of Hispanic subjects in a session increases.

Statistical versus Preference-based Discrimination

In another paper (Ferraro and Cummings, 2003), we analyze the reasons for the observed discrimination across sessions. If rational agents have no information about the behavior of the partner with whom they are bargaining, but have information about the average behavior of the group to which the partner belongs (e.g., an ethnic group), they may condition their decision on the average behavior of the group to which the partner belongs. Such behavior is called "statistical discrimination" (or "rational stereotyping"). If, in contrast, a rational agent simply prefers to behave differently when paired with a bargaining partner of particular characteristics, such behavior is called "preference-based discrimination" (or "a taste for discrimination"). The extent to which these two types of discrimination are empirically relevant in real world societies is controversial (Ladd, 1998).

Explaining the behavior of Responders as stemming from anything other than preference-based discrimination is difficult (how would the average behavior of the Proposers affect what a Responder would be willing to accept?), but the behavior of Hispanic and Navajo Proposers could be explained as statistical discrimination because Navajos are generally more likely to accept low offers in mixed sessions. Incorporating our data on subject expectations, however, lead us to conclude that although expectations do play a role, they cannot completely explain the behavior we observe. A taste for discrimination against Navajo Responders by Navajo and Hispanic Proposers represent the strongest explanation for the observed Proposer behavior.

A reader may find strange the conclusion that Navajos discriminate against Hispanics when they are Responders but against Navajos when they are Proposers. Previous Ultimatum Game analyses, however, suggest that the framing of the Responder's decision is different from the framing of the Proposer's decision, and thus the operative decision variables are different. In the former decision, issues associated with justice, fairness and equity are operative, but in the latter decision, strategic concerns and other-regarding preferences are operative. We do not pretend to understand *why* these observed patterns of preference-based discrimination take place, but we note that the results are consistent across alternative model specifications.

VI. Simulated Societies

Subjects in the experiment described above were only matched once at random. What if these subjects in each session were matched repeatedly, as they would be in a larger society? How would members of the Navajo and Hispanic cultures fare in such simulated societies? To explore this question, we take the subjects in each session and create ten thousand random matches (thus we are implicitly assuming no learning or updating of prior beliefs among our subjects). We are able to randomly re-match subjects because we have each Responder's decision for every dollar offer a Proposer can make in this game.

We present the results from this simulation in Table 7. For each simulated society, we present the average payoff to Proposers and Responders broken down by culture. We also present the "agreement rate" for the society, which is the percentage of interactions that resulted in positive payoffs for the bargainers. For example, the average payoff to Navajo Proposers in the All-Navajo simulated society was $4.15, while the average payoff to Navajo Responders was $3.41. These payoffs are substantially lower than the payoffs to Hispanic Proposers ($4.95) and Responders (4.84) in the All-Hispanic society.

Thus the Hispanic bargainers in a culturally homogenous society were better able to extract the available surplus than the Navajo bargainers in a culturally homogenous society. The differences stem from the larger agreement rate among Hispanic bargainers – Hispanic Proposers in the All-Hispanic society tend to make higher offers and Responders are willing to accept low offers.[19] As indicated in the last two rows of the table, Navajo bargainers would do better in a mixed society with Hispanic members, but Hispanic members do best in a culturally homogenous society.

Table 7. Summary of Simulation Results

	Average *Proposer* Payoff:		Agreement Rate:	Average *Responder* Payoff:	
Society	Navajo	Hispanic		Navajo	Hispanic
All-Navajo	$4.15	-----	75.59%	$3.41	------
All-Hispanic	-----	$4.95	97.91%	-----	$4.84
Majority-Navajo	$4.60	$4.79	93.53%	$4.64	$4.82
Majority-Hispanic	$4.08	$4.37	85.50%	$4.01	$4.31

Do such simulations offer insights into current day behaviors and outcomes? Without further experimentation, we cannot say. Our purpose here is to simply illustrate the way in which our experimental framework allows for simulations that can yield additional insights. Using more elaborate experiments that better mimic natural resource allocation decisions, analysts can conduct informative simulations of how conflict may affect future natural resource bargaining across cultural groups.

VII. Concluding Remarks

In this study, we depart from traditional empirical investigations to provide a framework to advance our understanding of the way in which culture affects economic outcomes. Our results clearly demonstrate that culture can matter in explaining variability in economic outcomes, and in more ways than previous research has suggested. Hispanic and Navajo subjects not only behave differently in the Ultimatum Game, but they also respond differently to

[19] In the All-Navajo session, there are also a few Responders who reject both low amounts and high amounts (called "non-monotonic" preferences and examined in Ferraro and Cummings (2003)).

the ethnic composition of the session.

As noted in the Introduction, these results have implications of general interest to environmental policy makers. Throughout the world, policies are formulated in societies characterized by mixed ethnicity, race and religion, in which there are clear majority and minority groups. Allocating the costs and benefits of public decisions across citizens (e.g., setting user fees, providing public goods) is a crucial policy issue. The way in which citizens value the potential policy outcomes, however, may not only be affected by the cultural group to which they belong, but also by the group's relative size in the society. The experimental approach we advocate can also shed light on current research programs analyzing endogenous preferences across different socio-cultural structures (Palacios-Huerta and Santos, 2004), and the role of cultural diversity in economic growth (Easterly and Levine; Alesina et al. 2003) and social policies towards the poor (Alesina and Glaeser, 2004).

Furthermore, the results suggest that economists may need to reconsider the way in which they control for ethnicity in empirical analyses. Economists traditionally use simple dummy (zero-one) variables for each ethnic group. Twenty-five years ago, Thomas Schelling (1978: 108) observed that "undoubtedly for some behaviors…it is proportions that influence people, not absolute numbers." Our results provide empirical support for Professor Schelling's observation.

The increased global relevance of diverse institutional arrangements for mediating the bargaining over natural resources (e.g., participatory resource management, community-based natural resource management, etc.) ensures that inter-cultural relationships will continue to have an impact on economic outcomes related to environmental resource for the foreseeable future. Economists cannot continue to sit on the sidelines. We hope that our analysis has shed light on an initial path for economists to begin participating in this growing area of research.

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